NASA SBIR/STTR Technologies

H2.02-9727 - Integrated Composite Rocket Nozzle Extension

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Identification and Significance of Innovation

ORBITEC proposes to develop an Integrated Composite Rocket Nozzle Extension (ICRNE) that will utilize internal intertwined lattice structures to join a high-temperature carbon composite nozzle extension to a regeneratively cooled nozzle made out of a high-strength metallic alloy. The ICRNE technology will allow composite materials to be directly integrated into a regeneratively-cooled nozzle section or thrust chamber, thereby eliminating the heavy bolted flange joint that is currently used. The resulting weight reduction will increase the thrust-to-weight ratio of the rocket engine. It will also eliminate the need for multiple seals in the bolted flange joints. The focus of the proposed Phase 1 effort will be to demonstrate the feasibility of the ICRNE technology by manufacturing and evaluating test specimens. A prototype ICRNE will also be designed and analyzed. In Phase 2, a prototype ICRNE unit will be fabricated, installed, and hot fire tested on an existing rocket engine.

Estimated TRL at beginning and end of contract: (Begin: 3 End: 4)

Technical Objectives and Work Plan

The Phase I effort will demonstrate the technical feasibility of the ICRNE technology through detailed analysis and experimental evaluation of test specimens. The Phase I ICRNE project will focus on the following key technical objectives: (1) define the detailed design requirements for the prototype ICRNE that will be demonstrated in a hot-fire test series during the follow-on Phase II effort; (2) develop a detailed preliminary design of the prototype ICRNE, including: materials evaluation and selection; structural design; and thermal and structural analysis; (3) develop a detailed manufacturing plan to fabricate ICRNE test specimens in Phase I and the prototype ICRNE in Phase II; (4) manufacture multiple test specimens that are representative of the prototype ICRNE design; (5) conduct tests to measure the mechanical and thermal properties of the ICRNE test specimens; and (6) analyze the test data and compare the required material properties as determined by the thermal and structural analysis of the prototype ICRNE design.

The work plan is composed of the following tasks specifically designed to meet these key technical objectives: Task 1: Define the Design Requirements, Task 2: Perform Detailed Design and Analysis, Task 3: Develop the Manufacturing Plan, Task 4: Manufacture the Test Specimens, Task 5: Evaluate the Test Specimens, and Task 6: Project Management and Reporting.

NASA Applications

The ICRNE technology addresses the needs of Subtopic H2.02 In-Space Propulsion Systems, which requests "high temperature materials, coatings and/or ablatives or injectors, combustion chambers, nozzles, and nozzle extension." ORBITEC expects the ICRNE technology to have direct and immediate application for RCS thrusters, OMS engines, upper stage engines, planetary ascent and descent engines, and new booster engines.

Non-NASA Applications

The DoD also requires advanced nozzle technology for new upper stage engines and boosters. The ICRNE technology can also be used to join dissimilar materials for a very broad range of applications in many industries, including wing leading edges for high speed transport aircraft, air breathing engines, turbines, industrial burners, and corrosion-resistant structures for naval vessels.

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